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DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Recovery of Solvent from Dry-Cleaning Machines.

We, MAX BÖHLER and FERDINAND WEBER, both of German Nationality and both of Memminger Str. 6—7, 89 Augsburg, Germany, trading as BÖHLER & WEBER KG, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a method and apparatus for the recovery of solvent from dry-cleaning machines and particularly for the condensation of the vapours and gases evolved in dry-cleaning machines, using spraying-nozzle cooling, in which a finely or very finely divided liquid is sprayed into the gas stream.

In dry-cleaning machines, devices which are operated by the spraying-nozzle method or in which a surface condenser is used, are predominantly used. The spraying-nozzle method employs a closed compartment through which passes the gaseous mixture of air, solvent and water vapour coming from the cleaning drum, and a fine mist is sprayed into the gas stream thus causing condensation of the solvent present therein.

The surface condenser system also comprises essentially a closed compartment through which the gas is passed. The compartment contains baffles or lamellar surfaces on which the gases of the solvent are deposited and condensed.

It has been found that the vapours are insufficiently condensed if the recovery period in dry-cleaning machines is reduced as would be desirable. On the other hand, it is inconvenient to increase the dimensions of the areas of condensation for the purpose of reducing the recovery time in the condenser. The fact that with adequately constructed condensers it happened frequently that water vapour as well as the solvent vapours escaped from the cleaning drum, was also felt to be a disadvantage. Part of the water present in the goods to be cleaned is thus removed therefrom and is likewise condensed in the condenser. The air returned to the drum is, however, extremely dry so that it cannot reintroduce water into the goods. In consequence, the goods are excessively dried with resulting damage and complaints.

It is among the objects of the invention to increase the efficiency in the condenser to a substantial extent at minimum cost and without substantially increasing the dimensions of the conventional condensers, so that the recovery time is perceptibly reduced, and excessive drying of the goods is at the same time avoided. It was particularly difficult to find an answer to this problem, since the two problems posed are contradictory and it is generally assumed that an increased efficiency of the condenser would necessarily result in excessive drying of the goods, or, conversely, that it would be impossible to reduce the condensation time if excessive drying of the goods was to be avoided.

According to the invention there is provided a method for the recovery of solvent from the cleaning drum of a dry-cleaning machine, by passing a stream of hot air through the drum, guiding the mixture of air and solvent vapour from the drum into a surface condenser where most of the solvent is condensed, conducting the mixture of air and condensate from the surface condenser into a zone where the air and the condensate are brought into contact with a spray of liquid, and where the condensate is separated from the air, and returning the air to the drum via a heater, or expelling it from the circuit.

It was surprisingly found that the combination provided in accordance with the

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invention was effective to reduce the condensation period substantially, and, at the same time, afforded the advantage that excessive drying of the goods in the cleaning drum was avoided. It has been proved in practice that the advantages hereinbefore described are actually obtained.

The efficacy of the method according to the invention resides in the fact that the re-evaporation of the solvent occurring in the conventional condensers is suppressed, for it has been found in the prior art methods that those quantities of the condensate which are just about condensed when the air passes through, re-evaporate and are carried into the circulating air stream. This particular portion of the solvent had therefore to be re-condensed.

A further effect of the method according to the invention is that a recondensation instead of the suppressed re-evaporation takes place, since the uncondensed solvent vapours leaving the condenser are condensed in the spraying zone. With the single passage of a gas stream, the condensation effect obtained exceeds substantially that obtained in the known dry-cleaning machines.

The air leaving the spraying zone is, however, at the same time enriched with fine droplets of the mist which are returned to the drum. In this manner excessive drying of the goods is avoided by virtue of the fact that the moisture present in the drying air is compatible with the percentage of moisture present in the goods.

It is possible to vary the percentage of moisture present in the air stream by temporary operation of the spraying unit according to the invention. In this way, it is possible to conform to the nature of each individual article and to create various conditions, under which the goods in the drum are dried.

In one advantageous modification of the method according to the invention, the spray of liquid is directed against a baffle, over which the impinging medium together with the solvent condensate may flow down. By this means, the air escaping from the condenser is forced to pass through the spray in each case, and it is ensured that the residual solvent vapours are delivered for condensation. At the same time, a sufficient supply of moisture for enrichment of the air with water is available on the baffle. It may be found to be advantageous to feed a steam condensate to the spraying nozzle, and thus to manage with a limited supply of water in the dry-cleaning machine, so that the costs of the operating medium used in carrying out the dry cleaning operation are reduced.

According to the invention, apparatus for the recovery of solvent from the cleaning drum of a dry-cleaning machine includes a cleaning drum, means for passing a stream of hot air through the drum, means for guiding the mixture of air and solvent vapour from the drum into a surface condenser where most of the solvent is condensed, means for conducting the mixture of air and condensate from the surface condenser into a zone where the air and the condensate are brought into contact with a spray of water, means for separating the condensate from the air and means for returning the air to a drum via a heater, or for withdrawing the air from the circuit.

One feature of the apparatus according to the invention is that at least one spraying nozzle for a liquid is provided in the zone between a surface condenser and the feed-shaft leading to the drum. The orifice of the spraying nozzle may preferably be directed towards a vertical wall, which may, for example, form the end wall of the housing which contains the condenser. The spraying nozzle may also be directed against the position at which the air leaves the condenser, thus avoiding from the start, an escape of the gases together with portions of the solvent.

In this respect it has been found to be advantageous to provide the condenser in a downwardly sloping position in the direction of an air heater, so that the gases flowing through apply a vertical component force to the condensed drops of liquid. A condenser in this position is not known in dry-cleaning machines. It may advantageously also be used in dry-cleaning machines without spraying nozzles

The efficacy of condensers in this position resides in the fact that the air stream produced assists in causing the condensate being formed to flow-off, since the air stream, as it were, forces the condensate to flow off the laminated walls. It will be understood that this is based on the assumption that the air flows through the condenser in the direction of its inclination, so that a vertical component of force of the flow is generated which causes the condensate to flow-off more quickly.

A collecting trough is connected to the condenser from which trough the baffle on which the sprayed liquid impinges, rises. As a result of the combination of the trough with the baffle and the sprayed liquid, re-evaporation of the condensate is avoided. Instead, a current is produced by which the condensate is forced to flow-off without being capable of re-condensation even though it is still in contact with the air.

A gap may be provided between the baffle and the air heater, so that heat transfer is largely avoided. This means also serves to prevent re-evaporation of the solvent. The baffle may preferably be constructed as a stream escaping from the condenser, the wall

deflecting wall for deflection of the air being either directly wetted with the liquid, or a mist formed of a fine spray of liquid, may be disposed upstream of the wall. It may also be of advantage for the deflecting wall to be formed of a fabric of textile threads or wire which is moistened at least temporarily. The air passing to the drum may be passed through this fabric. If the fabric is wetted with liquid, fine droplets of mist will follow the air stream and thus prevent excessive drying of the goods.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which

Figure 1 is a diagrammatic view of a dry-cleaning machine, and

Figures 2 to 4 are partial views of various embodiments of the condenser arrangement.

Figure 1 shows a diagram of the fundamental parts of a dry-cleaning machine 1, in which the air present in the cleaning drum 2 and enriched with vapours of solvent and water is fed by a blower 4, driven by a motor 5, through a shaft 3 and a feed-pipe 6 into a surface condenser 7. The solvent vapours are almost completely condensed in the condenser 7, whereas the air is returned to the drum 2 through a heat radiator 8 and a feed-shaft 12. The radiator 8 serves the purpose of heating the air before it is introduced into the shaft 12 of the cleaning drum 2, as hereinbefore described.

In order to obtain intensive condensation of the gases and vapour in the zone of the condenser 7, a spraying-nozzle unit 10 is provided in the zone 9 between the condenser 7 and the heat radiator 8. A liquid, usually water, is introduced by the nozzle 10 into the air stream which is just leaving the condenser 7. Thus, re-evaporation of the condensate is safely avoided, and, moreover, additional condensation work is performed. In the embodiment illustrated in Figure 1, the flow issuing from the spraying nozzle is directed against the discharge end 11 at the rear of the condenser 7. The condenser 7 is preferably provided with internal laminar walls between which the air flows over the whole width of the condenser 7. The liquid sprayed by the spraying nozzles, to which liquid the condensate of the solvent has been added, passes into a trough-shaped cavity 19 and thence into a drain 18 which leads to the water-separating tank.

In the construction illustrated in Figure 2, the spraying-nozzle unit 10 is provided at a much higher level and acts in the direction of a baffle 13 on which the air leaving the condenser 7 has to impinge in order to reach the radiator 8. During its return flow, the air, and the solvent vapours present therein cannot but pass through the spray of the spraying unit 10. The solvent vapours are forced under pressure by the droplets of the spray against the baffle 13, which is provided at an angle or in a vertical position so that the solvents condensed thereon and the sprayed liquid have to flow downwards into the drain 18. On the other hand, the air flowing through the spray is enriched with finely dispersed drops of water which are thus carried into the drum 2 and prevent excessive drying of the goods. The spraying unit thus causes the air introduced into the drum 2 to be moistened.

The construction shown in Figure 3 is based on a spraying-nozzle unit 10 which produces a mist 15 formed of a fine spray of liquid upstream of the baffle 13, through which mist the drying air has to pass before it can reach the radiator 8.

It has been found to be advantageous in all cases for the baffle 13 to be provided at a distance from the radiator 8, so that a gap 14, sufficient to prevent a transfer of heat from the radiator 8 to the baffle 13, is formed between the two parts. Re-evaporation of the condensed liquids on the baffle 13 is thus avoided.

Finally, in the embodiment illustrated in Figure 4, a fabric 6 which may, for example, consist of closely woven textile threads or metal wires, and which is, at least temporarily moistened by the spraying unit 10, is provided. In this manner, the recondensation obtained in the preceding embodiments is obtained, and, in addition, the fine fabric serves for the storage of water in the form of extremely fine droplets, so that the air passing through may be enriched with such droplets.

As before, the solvent is condensed on the baffle 13 and caused to flow-off downwardly thereon.

The invention permits the spraying-nozzle unit 10 to be rendered operative at any desired time. Thus, the spraying-nozzle unit 10 may, for example, be rendered inoperative during the initial period of the condensation time, since it is known that during this period a maximum amount of solvent is condensed within a very short time, for the reason that the condenser 7 carries out a sufficient amount of the condensation work. It is, however, known that the complete condensation of the residual solvent consumes substantially more time. During this period, the spraying-nozzle unit 10 may be started in addition to the condensation proceeding in the condenser 7, so that the total condensation time may be considerably reduced. The spraying-nozzle unit 10 may also be coupled with an hygrometer, by which the unit 10 is automatically started when the moisture conditions in the cleaning drum 2 have dropped below a determined value. It will be understood that there are many possibilities of obtaining various effects with the spraying-nozzle unit 10.

It has been found to be essential that the condenser 7 should be provided at an angle, so that its bottom surface 17 slopes from the blower 4 in the direction of the radiator 8. The air approaching from the drum 2 is then passed through the condenser 7 in a direction substantially parallel to the said bottom surface 17. The air stream thus also flows in a downwardly sloping direction. This measure is taken in order to ensure that the liquids condensed on the surfaces of the condenser are forced to flow rapidly downwards by the vertical component force of flow of the air, so that, by this means also, re-evaporation of the condensate is avoided. If the air were to be passed horizontally through the condensers 7, its effect on the condensate which is about to flow down would be merely that of a frictional and braking action. The more steeply or the more obliquely the air is passed through the condenser 7, the more rapidly will the condensates flow-off from the walls. It will be readily understood that this measure may be taken not only in combination with the spraying nozzle unit 10, but that in dry-cleaning machines without a spraying-nozzle device 10, the condensers 7 may be provided in a position suitable to ensure that this measure alone assists in impeding or preventing re-evaporation of the condensate.

WHAT WE CLAIM IS:—

1. A method for the recovery of solvent from the cleaning drum of a dry-cleaning machine, by passing a stream of hot air through the drum, guiding the mixture of air and solvent vapour from the drum into a surface condenser where most of the solvent is condensed, conducting the mixture of air and condensate from the surface condenser into a zone where the air and the condensate are brought into contact with a spray of liquid, and where the condensate is separated from the air, and returning the air to the drum via a heater, or expelling it from the circuit.

2. A method according to claim 1, in which the sprayed-in liquid is directed against a baffle, on which the impinging medium may flow-off together with the added particles of solvent.

3. A method according to claim 1 or claim 2, in which the steam condensate is used for feeding the spraying nozzle.

4. Apparatus for the recovery of solvent from the cleaning drum of a dry-cleaning machine, including a cleaning drum, means for passing a stream of hot air through the drum, means for guiding the mixture of air and solvent vapour from the drum into a surface condenser where most of the solvent is condensed, means for conducting the mixture of air and condensate from the surface condenser into a zone where the air and the condensate are brought into contact with a spray of water, means for separating the condensate from the air and means for returning the air to a drum via a heater, or for withdrawing the air from the circuit.

5. Apparatus according to claim 4, in which at least one spraying nozzle is provided in the zone between an ordinary condenser and the feed shaft leading to the drum.

6. Apparatus according to claim 4, in which the orifice of the spraying nozzle is directed against a substantially vertical wall which, for example, may constitute the end wall of the housing containing the condenser.

7. Apparatus according to any of claims 4 to 6, in which the condenser is provided at an angle, so as to slope down in the direction of the air heater, so that the gases flowing through the condenser apply a vertical component force to the drops of condensed liquid.

8. Apparatus according to any of the preceding claims, in which, adjoining the condenser is a collecting trough from which the baffle rises so that the sprayed liquid may impinge thereon.

9. Apparatus according to claim 8, in which provided between the baffle and the air heater is a gap, by virtue of which a transfer of heat is substantially prevented.

10. Apparatus according to claim 8 or claim 9, in which the baffle is provided in the form of a deflecting wall for the air stream issuing from the condenser, the wall being wetted directly by the liquid, or a mist formed as a fine spray of liquid is disposed upstream of the wall.

11. Apparatus according to claim 10, in which the deflecting wall is formed of an at least temporarily moistened fabric, made of textile threads or of metal wire.

12. A method of condensing the vapours and gases evolved in dry-cleaning machines, substantially as hereinbefore described.

13. Apparatus for condensing the vapours and gases evolved in dry-cleaning machines, substantially as hereinbefore described and illustrated in Figure 1 of the accompanying drawings.

14. Apparatus for condensing the vapours and gases evolved in dry-cleaning machines, substantially as hereinbefore described and illustrated with reference to Figure 2 of the accompanying drawings.

15. Apparatus for condensing the vapours and gases evolved in dry-cleaning machines, substantially as hereinbefore described and illustrated with reference to Figure 3 of the accompanying drawings.

16. Apparatus for condensing the

vapours and gases evolved in dry-cleaning machines, substantially as hereinbefore described and illustrated with reference to Figure 4 of the accompanying drawings.

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1 SHEET This drawing is a reproduction of the Original on a reduced scale

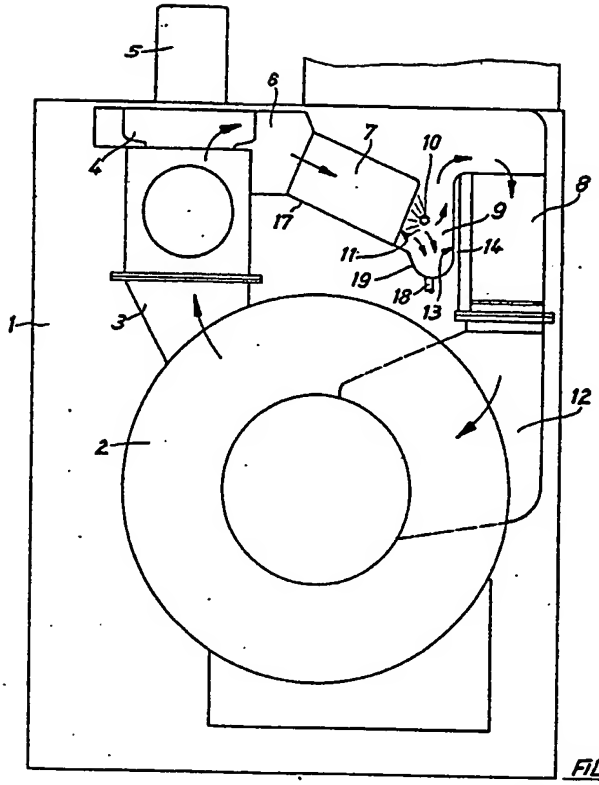

FIG.1

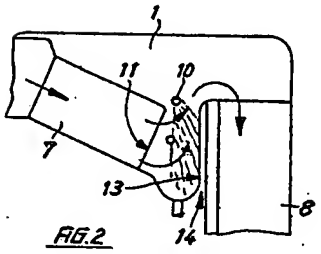

FIG.2

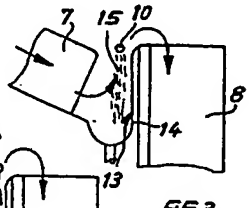

FIG.3

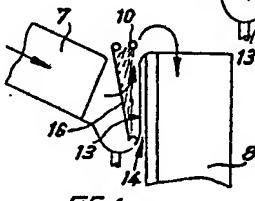

FIG.4